Accurate Strength & Life Prediction

Completed Technology Project (2014 - 2020)

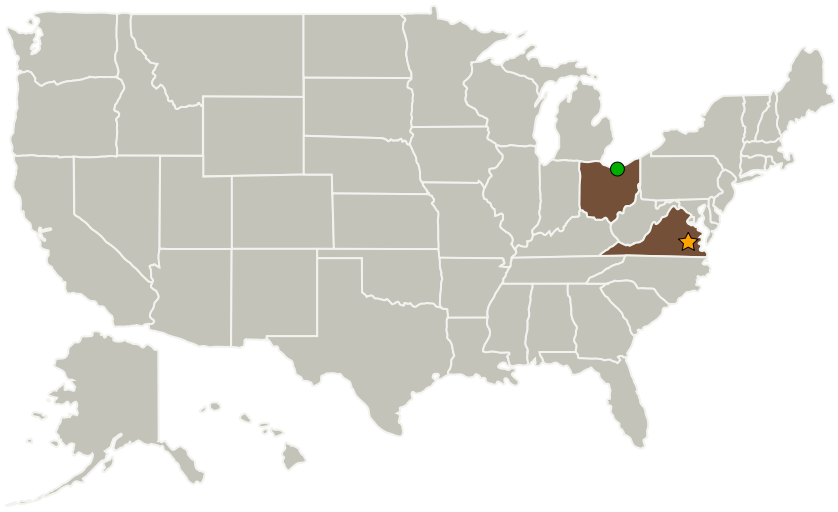
Project Introduction

The Accurate Strength & Life Prediction challenge develops validated strength and life prediction tools with known accuracy for complex composite structures and standardized procedures for their reliable use.

Anticipated Benefits

This technical challenge addresses Verification and Validation methods for applications in strength and life prediction tools for complex composite structures and standardized procedures. The development of high fidelity analysis tools will enable reliable predictions of strength and life of composite structures with damage or defects, along with prediction of structure failures when subjected to high-energy impacts. This research supports the feasibility of manufacturing future aircraft in ultra-efficient but non-traditional configurations.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
Arizona State University-Tempe(ASU)	Supporting Organization	Academia Alaska Native and Native Hawaiian Serving Institutions (ANNH)	Tempe, Arizona
Aurora Flight Sciences Corporation	Supporting Organization	Industry	Cambridge, Massachusetts
Collier Research & Development Corporation	Supporting Organization	Industry	Hampton, Virginia
General Electric Company	Supporting Organization	Industry	Niskayuna, New York
●Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio
Lockheed Martin Inc.	Supporting Organization	Industry	Palo Alto, California
McNAIR	Supporting Organization	Industry	
National Institute for Aviation Research	Supporting Organization	Academia	Wichita, Kansas

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Organizational Responsibility

Responsible Mission Directorate:

Aeronautics Research Mission Directorate (ARMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Advanced Air Vehicles

Project Management

Program Director:

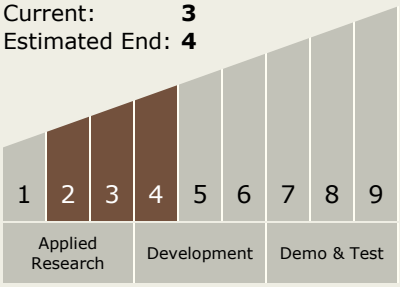
James A Kenyon

Project Manager:

Richard D Young

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **4**



Technology Areas

Primary:

Continued on following page.

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National Institute of Aerospace	Supporting Organization	Academia	Hampton, Virginia
Northrop Grumman Aerospace Systems(NGAS)	Supporting Organization	Industry	Redondo Beach, California
The Boeing Company(Boeing)	Supporting Organization	Industry	Chicago, Illinois
The University of Texas at Arlington(UTA)	Supporting Organization	Academia Asian American Native American Pacific Islander (AANAPISI), Hispanic Serving Institutions (HSI)	Arlington, Texas
United Technologies Corporation	Supporting Organization	Industry	Farmington, Connecticut
University of California-San Diego(UCSD)	Supporting Organization	Academia	La Jolla, California

Primary U.S. Work Locations	
Ohio	Virginia

Project Transitions

October 2014: Project Start

Technology Areas *(cont.)*

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.1 Materials
    - TX12.1.2 Computational Materials

Other/Cross-cutting:

- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.5 Mission Architecture, Systems Analysis and Concept Development
    - TX11.5.2 Tools and Methodologies for Performing Systems Analysis

Target Destination

Earth

September 2020: Closed out

Closeout Summary: Progressive Damage Subcomponent Validation: Completed test/analysis correlation for four-stringer t est articles with initial damage, Teflon inserts or impact damage, subjected to static loading and single-stringer specimens with Teflon inserts subjected to fatigue loading. The analyses predicted well the observed damage modes and sequence of damage events and predicted max loads within 15% of the average experimental failure load for the four-stringer panel wit h Teflon inserts. High Energy Dynamic Impact Complex Subcomponent Validation: Post-test simulations of the sub-scale curved configured test article were conducted with LS-DYNA MAT162, MAT261 and Peridynamics and compared with test re sults. For backside deflection in the mid-bay area, Peridynamics showed the best correlation with test data at -17.5% error of the peak value, meeting the minimum success criterion. MAT162 and MAT261 over-predicted the deflection at 103.5% a nd 38.3% respectively. For the threshold penetration velocity the MAT261 model provided the most accurate prediction, wi th an error of less than 4% compared to the test result, meeting the stretch success criterion. Rapid Design Tools - Opti mizer Demo on Component: BVID/CAI and Ply-Drop (UTRC), 2-Bay Crack (Spirit/Boeing), Post-buckling and Bonded Joint (Collier), were validated through exercising the tools and comparing results to test data. Team members (Collier, Aurora, S pirit AeroSystems, Boeing, Northrop Grumman, UTRC, NASA) used the HyperSizer® stress framework with rapid tools integ rated to analyze/size global finite element models of company-specific structures. Some members reported qualitative and quantitative benefits using the stress framework regarding design cycle times.

Project Website:

https://www.nasa.gov/aeroresearch/programs/aavp/ac